



In Situ Treatment for PCBs in Sediment – Treatability to Implementation

02/14/2019

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Tenth International Conference on Remediation and Management of Contaminated Sediments February 11 – 14, 2019 New Orleans, Louisiana

PRESENTATION OUTLINE

Background

Site Characteristics

Feasibility Study

Treatability Study

Remedial Design

Baseline Data Collection

Remedial Implementation

Monitoring



Site Characteristics

- Creek and tidally influenced estuary
- Industrial and residential area
- Partial navigation channel
- Recreational use
 - Boating
 - Swimming
 - Fishing
- Creek discharging into the cove
- 8 to 10 feet water depth in the cove
- Silty with little sand
- Organic carbon ~ 1 5.5 %
- PCB contamination
 <1 3600 mg/kg PCBs
- In Situ treatment area total PCB concentrations generally < 3 mg/kg







Feasibility Study: Remedial Technologies Considered



- Removal
 - Areas of high concentration
 - Hydrodynamic high erosion potential
 - Habitat
- Capping
 - Limited potential due to shallowness of creek and the navigation channel in cove area
- In Situ Treatment and Monitored Natural Recovery (MNR)
 - Potential option for areas of relatively low concentrations and contamination limited to surface sediments



Treatability to Implementation Process



| Treatability Study as part of the Feasibility Study | Effectiveness of technology to achieve remedial goals as part of the site remedy |
|--|--|
| Remedial Design | Development of implementation approach |
| Baseline Monitoring | Establish data set for future effectiveness evaluation |
| Remedial Implementation | Quality Control confirmation sampling |
| Long Term Monitoring for Effectiveness | Verification of implementation effectiveness and stability |

In Situ Treatment Treatability Study

- Evaluation of sediments with approximately 1 2.5 mg/kg total PCBs
- Evaluation of 5 amendment materials
 - Granular activated carbon (GAC bituminous coal derived)
 - Powdered activated carbon (PAC – bituminous coal derived)
 - Organoclay
 - Biochar (pinewood-derived)
 - Coke
- Initial evaluation of amendments to reduce porewater concentrations of PCBs
 - Use of passive samplers for PCB sediment porewater
 - Laboratory bioaccumulation study







Figure 3. Laboratory bioaccumulation experiment using the freshwater oligochaete L. variegatus.

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Treatability - Porewater Reduction Results

- PAC and biochar reductions 94.9 – 99.8%
- GAC reductions 67 81.6%
- Organoclay and coke reductions 36 – 58%
- Biochar, GAC and PAC had greater reductions for lighter PCBs
 - Long term field studies have shown the heavier
 PCBs will have higher reduction over time.



Treatability - Reduction in Total PCB Bioaccumulation

- Amended sediment and freshwater oligochaetes
- 28 days exposure period
- PAC (5%)
- Biochar (5%)
- Collection and depuration of worms
- Analysis of worm tissue for PCBs
- 92 96 % reduction in tissue concentrations for PAC
- 96 % reduction in tissue concentrations for Biochar







Remedial Design



- Combination remedy of dredging and *in situ* treatment
- Selection of PAC for the *in situ* treatment based on the treatability results and FS assessment (cost-effective placement technology)
- Completion of dredging for areas of higher PCB concentrations followed by application of a residuals management layer
- Application of PAC for the *in situ* treatment in areas with PCB contamination in the surface sediment between 0.7 mg/kg and 2.5 mg/kg
- Approximately 1/3 of the area (6 acres) of contaminated sediment to be dredged and 2/3 of the area (13 acres) with *in situ* treatment
- Work completed under a pair of Risk-Based Removal Application Approvals with the US EPA
 - One for the dredging
 - One for the in situ treatment (Contingent on monitoring)





Baseline Monitoring – Pre In Situ Treatment

- Five sediment locations across the *in situ* treatment area
- Collection of sediment cores for profiling 4 depth intervals from 0 to 12 inches
- Collection of bulk sediment for laboratory ex situ testing
- Deployment of passive sediment porewater samplers for 28 days for *in situ* sampling
- Laboratory analysis of sediment for PCB congeners, total organic carbon, and black carbon





Laboratory Bioaccumulation Tests – Ex Situ

- Use of *Lumbriculus variegatus* for 28 day bioaccumulation test
- 5 replicates for each location performed along with control site samples
- Site water used for testing
- Tissue samples collected at end of test for PCB congener and lipid analysis
- Sediment porewater samples collected for the exposure sediment using passive samplers



Baseline Bioaccumulation and Sediment Porewater Results



| Sample Location | Average Tissue PCB Concentration (ug/g) Dry Weight | RSD | | |
|--------------------|--|------|----------|-------------------|
| 1 | 0.273 | 21 % | | |
| 2 | 0.793 | 26 % | | |
| 3 | 0.435 | 14 % | | |
| 4 | 0.369 | 26 % | Sample | Average Porewate |
| 5 | 0.276 | 28 % | Location | PCB Concentration |

5 replicate sediment tests performed at each sample location





| Sample Location | Average Porewater PCB Concentration (ng/L) | RSD |
|--------------------|--|------|
| 1 | 11.2 | 11 % |
| 2 | 57.1 | 7 % |
| 3 | 22.7 | 21 % |
| 4 | 11.2 | 14 % |

3 replicate porewater samples collected at each sample location



Remedy Implementation – In Situ Treatment

- 13.7 Acres of *in situ* treatment
- 2,500 tons of AquaGate + PAC (10%)
- Cable-propelled Barge Spreader to place material
- Initial test runs to establish barge and spreader operation rates to achieve project goals of ~5% PAC
- Application challenge consistent placement of an ~ 1 inch layer of the AquaGate + PAC





Remedial Construction Quality Control

- Manufacturing quality control documentation verified material quality (PAC content)
- Multiple lines of evidence used to verify placement
 - Application rate calculated 178 tons/acre
 - Tracked daily by usage and covered area
 - Aggregate thickness measurements
 - 15 cores/acre
 - 214 total samples
 - Total organic carbon and black carbon analysis
 - 15 cores/acre
 - 214 total samples analyzed
 - Sample buckets collected for verification of quantity of PAC placed





Remedy Placement Verification

- Thickness measurement criteria 0.95 1.8 inch
 - Average of 1.1 inches measured by core and bucket samples
- TOC and black carbon criteria 2.4% 4.5 % organic carbon added
 Average 2.7 % organic carbon
- Bucket Collection Test Sample Results
 - Verification of PAC Placement
 - Initial Barge/Spreader Calibration*
 - Full Area In Situ Placement







Post Remedy Monitoring Plan

- Repeat of Baseline sampling approach porewater sampling and bioaccumulation testing at same 5 locations
- Year 1, 3 and 5
- Criteria 70% reduction in tissue bioaccumulation concentrations
- Criteria 80% reduction in porewater concentrations



Post Remedy Monitoring – Year 1



- Same Sampling and testing approach as was completed for the Baseline
- 5 Monitoring locations of *In Situ* sediment porewater samples using Passive sampling methods for dissolved phase concentrations
- 3 sediment porewater samples and a surface water sample at each monitoring location
- Collection of bulk sediment for Bioaccumulation tests and ex situ sediment porewater samples
- Bioaccumulation tests performed as 5 replicates for each monitoring location and a laboratory control sediment
- Tissue samples collected for PCB congener analysis
- Collection of cores from each monitoring location to measure organic carbon content at 4 depth intervals

Monitoring Year 1 - Total Organic Carbon by Sediment Depth intervals





- Three cores collected from each monitoring location. Composite samples for each interval collected and analyzed for Total Organic Carbon and Black Carbon
- Year 1 results show presence of activated carbon and mixing to a depth of 4 inches based on increase in TOC above baseline



Monitoring Year 1 - Preliminary Results

- 28 day Bioaccumulation Tissue
 - > 85 % reduction in total PCB tissue concentrations from Baseline
- In Situ Porewater
 - > 90 % reduction in total PCB sediment porewater concentrations from Baseline
- Surface Water
 - > 65 % reduction in total PCB surface water concentrations from Baseline



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Summary

- Treatability Study demonstrated activated carbon effectiveness to reduce sediment porewater concentrations and benthic bioaccumulation of PCBs
- Remedy design completed with *In Situ* treatment with powdered activated carbon as part of a combination remedy
- Implementation of the Remedy successfully completed with comprehensive verification approach
- Initial Monitoring at Year 1 demonstrates effectiveness close to the treatability study results



Questions?



